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A STUDY OF THE REQUIREMENTS FOR STAFF, EQUIPMENT AND TRAINING FOR A NATIONAL CARTOGRAPHIC CENTRE

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A STUDY OF THE REQUIREMENTS FOR STAFF, EQUIPMENT AND TRAINING FOR A NATIONAL CARTOGRAPHIC CENTRE

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1. The designation "National Cartographic Centre" is intended to mean a national Survey Department responsible for the provision of the basic survey data and all requirements of maps and other survey services for the country concerned. Good Maps compiled from up-to-date topographical and engineering surveys are an essential requirement for planning a country's development, for the execution of development projects such as communications, power, irrigation and town planning, and for the exploitation of its natural resources. As the efficient organisation of a Survey Department has an important influence on requirements of staff and equipment, this study will also consider that vital aspect.

2. It is usual for a Survey Department to be a government organisation mainly because of the importance to national development and security of the services rendered by the Department. For this reason it is very necessary that newly independent under-developed countries should establish an efficient national Survey Department without delay. Because the timely provision of survey data is so important for a country's economic development, it is often necessary for the production of the Survey Department, at least in its early stages, to be supplemented by having mapping carried out on contract by experienced commercial organisations. Several such organisations exist and these have been carrying out mapping projects of all types, on an international basis, for the past fifteen years or so.

3. Duties of a Survey Department:

In general, the objects and duties of a national Survey Department are as follows:-

(a) Survey Framework. The establishment of the basic survey framework of the country consisting of an evenly distributed series of permanent points whose positions on the earth's surface and heights above sea level are accurately known. In most countries certain framework data already exists and one of the first duties of the Department would be the collection and collation of such data and the planning of its orderly completion.

(b) Topographical Mapping. The planning and execution of basic topographical map series to cover the whole country.

(c) Engineering Surveys. The undertaking of large scale engineering surveys required for specific development projects.

4. Additional Duties:

In detailing the duties of the Survey Department the specific requirements and circumstances of individual countries must, of course, be considered. The following additional and important types of surveys may well be included in the general duties of the Department:-

(a) Cadastral Surveys. In order that an efficient system for the measurement, delineation and recording of individual land holdings can be established, it is necessary for this specialised type of land survey to be carried out. It provides the basic data necessary for the registration of ownership of land and for land tax purposes.

(b) Geological Surveys. These are most important for the planned exploitation of a country's mineral resources. As the topographical map provides the basic medium on which geological information is recorded, this type of survey is often included among the duties of a newly formed Survey Department. At a later stage, however, it is probable that a separate Geological Survey Department would be formed.

5. Photogrammetric Mapping:

The basis for modern surveys of the land is almost invariably the vertical air photograph and a national Survey Department should be planned to use this medium almost entirely for mapping of all types and scales. The science of accurate measurement from air photographs and the preparation of maps either with or without contours by this means is known as "photogrammetry". This Study, therefore, pre-supposes that photogrammetric techniques will be used for all mapping carried out by the national Survey Department.

6. Advice and Consultancy Services:

In some countries there exist educational institutes which can provide advice on a consultancy basis and also training facilities in all branches of photogrammetric mapping. These institutes provide facilities for either the training of personnel in their own establishments or for sending instructors to work in newly formed national Survey Departments. They would also act as consultants in advising a country on the formation, organisation, equipping and staffing of a Survey Department. Some commercial organisations mentioned in Paragraph 2 also provide similar facilities and one such organisation is known to have taken full responsibility, as consultants, for the formation and initial operation of a National Cartographic Centre. Countries who are considering the establishment of Survey Departments would be well advised to employ one of the organizations mentioned above in order to ensure that the new Department is properly organised to meet the country's particular requirements, that their personnel are trained by experienced instructors and that the best advice is available on equipment and operational organisation.

7. Organisation of Survey Department:

Photogrammetric mapping techniques lend themselves to centralized production. Unless internal national policy or the size or the administrative composition of a country dictate otherwise, it is recommended that all the map production equipment and potential of a Survey Department should be centralized. In this way the Department will operate with maximum efficiency and economy. A partial exception to this might be the desirability, in countries of large area, of having provincial or other geographically de-centralized offices as field headquarters for framework control parties and other field operations. If the Department has a Cadastral Survey Division it will certainly be necessary to have provincial headquarters for both the cadastral field operations and for the preparation and possibly the storage of cadastral records. In addition to the administrative wing, it is recommended that a Survey Department should be organized into the following technical divisions; each with its necessary complement of divisional manager and section supervisors:-

(a) Photographic Division. It is not usual for a national Survey Department to operate its own aircraft for air photography. Economic and operational considerations usually influence the decision to have all air photographic requirements for the Department met, either by the national Air Force, or by contract with commercial air survey organizations. The Photographic Division, therefore, only provides facilities for printing and enlarging from air photographic negatives, for the making and copying of air photo mosaics and for the operation of a library containing films and prints of all air photographic coverage of the country.

(b) Control Division. This division provides the basic framework control data required for all types of mapping and includes a section for carrying out the computations involved in the provision of this data. The Division is also responsible for the collection of such "field" information as geographical names, classification of routes, 'man made' structures, etc., and additional data which cannot be obtained from air photographs.

(c) Mapping Division, which is sub-divided into:-

(i) Photogrammetric Plotting Section.
(ii) Compilation Section
(iii) Fair Drawing Section.

The Plotting Section, using different types of photogrammetric plotting machines, produces the basic maps direct from the air photographs. The Compilation Section projects these 'plots' on to standard map sheet format and prepares them for the Fair Drawing Section which produces the originals of the final map sheets.

(d) Map Reproduction Division. This Division prints the map sheets in quantity and in colours, as required, using photo-lithographic equipment and processes from the 'fair drawn originals' produced by Section (c)(iii) above.

8. Staff:

(a) Requirements of staff fall into two main categories, professional and technical. Professionally qualified personnel should fill senior executive posts in the Control and Mapping Divisions. In addition, it is desirable that such personnel should also comprise a proportion of the land surveyors in the Control Division and the photogrammetrists in Section (i) of the Mapping Division.

(b) The following important trades would be classed as 'technical' and in order to be so employed personnel should complete specialized training courses:

(i) Photographic Division: Photographer, Mosaicer.
(ii) Control Division: Land Surveyor, Computer.
(iii) Mapping Division: Photogrammetric Plotting Section - Photogrammetrist, Machine Operator.

Fair Drawing Section - Draughtsman (Scriber), Type Composer.

(iv) Map Reproduction Division: Process Photographer, Photomechanical Processer, Lithographic Printer.

(c) Before receiving training necessary to obtain professional qualifications as Land Surveyors and Photogrammetrists, personnel should have been educated up to at least university entrance standard with particular emphasis on mathematics and science. For the technical trades it is also desirable that personnel should have completed their secondary education, again with emphasis on mathematics and science. There are certain technical trades, however, for which personnel could be accepted for training with lower basic educational standards. The relaxation of these standards depends mainly on the quality of the personnel and such trades would include those in the Photographic Division, Draughtsmen (Scribers), Type Composers, certain photo-lithographic trades, and Photo Interpreters.

9. Training:

(a) It is probable that under-developed countries would not have facilities for providing professional training and qualifications in their own countries. In these cases it is recommended that selected personnel should be sent to foreign technical institutes where they could obtain the necessary qualifications. On returning to their own country such personnel would form the technical 'back bone' of the new Survey Department.

(b) For the other technical trades, while it would be desirable for 'key' personnel to have training abroad, it is quite possible to conduct training courses in the country concerned. Instructors and general advice on a consultancy basis could be obtained from foreign organizations as mentioned in Paragraph 6 above. It is, of course, essential that instructors so provided should be experts in their professions and trades, and that they should have had instructional experience on projects of a similar nature. Such experience would have included the preparation and implementation of syllabi for the various training courses.

(c) Assuming that trainees have the basic educational standards mentioned in Paragraph 8(c) above, the following minimum training periods are recommended before trainees are employed on production:-

(i) Land Surveyor, Photogrammetrist, Machine Operator, Lithographic Printer and Process Photographer .. 1 year
(ii) Photographer, Photomechanical Processer, Map Compiler .. .. 6 months
(iii) Draughtsman (Scriber), Mosaicer, Photo Interpreter, Computer . .. . 3 months.

The above periods assume that full time training has been carried out by qualified instructors based on a syllabus prepared by experienced Consultants.

(d) It is recommended that the number of trainees per instructor should not exceed ten. It is also desirable that foreign instructors should be assisted by

technically qualified personnel of the country concerned and the obvious choices for these assistants would be those personnel who have completed professional and technical courses abroad. It is, therefore, necessary to select such personnel and send them to overseas technical institutes at least a year before it is desired to start the full scale national training programmes.

(e) In conducting a series of technical training courses as envisaged above, it is recommended that the following important principles should be adhered to:

(i) Trainees should be subjected to continuous and whole-time courses in strict accordance with the syllabus, and they should not be required to perform any other duties during the training period.

(ii) Trainees should be immediately removed from any course if the instructor confirms their unsuitability for the particular trade for which the candidate has been selected. Extra trainees should be selected at the beginning of each course to provide for this type of 'wastage' due to unsuitability.

(iii) On no account should trainees be employed on production until the full course has been completed and the instructor has recommended their trade qualification. If necessary, trainees may have to repeat a particular course before they can be certified as fit to be employed on production work.

(f) For a balanced Survey Department, designed to carry out topographical mapping and also large scale engineering surveys normally required for development projects, the following ratios of the major professions, trades are suggested. These ratios assume that some modern topographical maps exist already, that priority is to be given to mapping for development projects and that no systematic cadastral mapping programme is to be undertaken until the new Department has been in full production on other types of mapping for at least three years:

(i)	Land Surveyors	3
(ii)	Photogrammetrists and Machine Operators	5
(iii)	Draughtsmen/Scribers	6
(iv)	Photographers	2
(v)	Map Reproduction Personnel	2
(vi)	Computers	1

To explain the application of the above ratios, if the number of land surveyors was 18, then the approximate number of Photogrammetric machine operators should be 30, draughtsmen 36, and so on.

10. Equipment:

(a) The following major items of equipment are suggested, the numbers of individual items depending on the required rate of production of different types of mapping:

(i) Field Survey Equipment. In addition to standard theodolites and levels (both geodetic and topographical), high precision distance measuring equipment such as Tellurometers and/or Geodimeters should be provided.

(ii) Photogrammetric Plotting Equipment. First and probably also second order plotting machines would be required. If small scale topographical mapping is to be undertaken, and if air photography at a

suitable scale is likely to be available, some third order machines would also be desirable and economic. A proportion of the plotting machines should be suitable for aerial triangulation and it is recommended that this proportion should be about 1 to 10. For special operations such as cross-sectioning, some of the first order machines should be fitted with automatic co-ordinate printers. If analytical aerial triangulation is to be undertaken, a first order stereo-comparator would also be required.

(iii) Photographic Laboratory Equipment. In addition to standard contact printers and enlargers, one or more precision rectifying enlargers and some electronic contact printers are recommended.

(iv) Map Reproduction Equipment. A precision process camera, preferably of the automatic scaling type, standard photo-mechanical equipment and automatic feed offset printing machines would be required. The number of copies of map sheets to be printed and the number of colours will determine the most satisfactory type of printing machines and whether they should be single or multi-colour.

(v) Computing equipment. Standard computing machines will be required. Although it is doubtful if the size of the Department would justify the purchase of an electronic computer, it would be advantageous if the services of such a computer were available to the Department on a part-time basis.

(vi) Map Compilation Equipment. For this section the major requirements are magnifying stereoscopes and a co-ordinatograph.

(vii) Drawing Office Equipment. As the majority of the fairdrawing will be carried out using the 'scribing' process, standard sets of scribing tools would be needed. For composing and letterpress required on map sheets, some form of phototypesetter would be preferable to using hand lettering procedures.

(b) Supplies of photogrammetric plotting equipment are strictly limited and there are, at the present time, delays of up to two years in deliveries of certain first order equipment. Orders must, therefore, be placed well in advance of requirements and account must be taken of this when planning the phased build-up of a Survey Department.

(c) For training purposes, it is recommended that the more simple anaglyphic type of equipment should be obtained. This is second order equipment and would ultimately be included in the productive potential of the Department. Deliveries of this equipment are considerably better than for first order machines, but even so 6 - 8 months' delay is likely.

11. Production:

(a) It is again emphasised that it is a mistaken policy to begin productive work before the training syllabus has been completed and personnel can be relied upon to produce accurate work. Map making is a precise science and the quality of the final map sheet depends on the skill and reliability of the series of individuals responsible for each stage of the work. One error in the map makes the whole sheet suspect, and it is therefore essential that each person involved in its production should be qualified in his (or her) particular trade.. This can only be achieved after thorough training.

(b) Efficient map production requires sound organization and planning. The basic material is the air photograph which can only be obtained in suitable weather,

usually occurring at particular times of the year. The framework control is also dependent on weather, but not to such a degree as is the air photograph. The execution of a successful map production programme therefore requires a considerable amount of planning and the close co-ordination of all phases of the operation. Even after the basic data is available in the headquarters of the Department, close divisional and inter-divisional co-ordination is necessary so that production can continue smoothly from the basic data through the plotting, drawing and the final printing stages. This can only be achieved by planning, co-ordination and overall control.

(c) As an aid to future production planning, and also for cost analysis, it is recommended that detailed job records, on a man/hour basis, should be kept by each Division and Section to include all stages of the work. The technical planning office should maintain a statistical section to collect and collate this data.

12. This paper is intended to indicate the essential role of a National Survey Department in the economic development of a country and to emphasise various matters which must be considered when planning the creation of such a Department. There is a fund of experience and knowledge existing in certain national and international organizations, and it is strongly recommended that any country considering the formation of a national Survey Department should avail themselves of this advice and experience, without delay.

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